**On the Fall X2 Adaptive Management Plan (Milestone Draft) for the Review Panel**

The now-remanded biological opinion (BiOp) on long-term operations of the Central Valley Project and State Water Project contains a reasonable and prudent action (RPA component 3, hereinafter "Fall X2 Action") "to improve fall habitat for delta smelt through increasing Delta outflow during fall," which is intended to "increase fall habitat quantity and quality." (Both Biop at 282). Acknowledging that the BiOp misuses the word "habitat" in its evaluation of flow effects on delta smelt and recognizing overarching uncertainties associated with the action (see SFCWA paper on the fall X2 hypothesis), the Fall X2 Action, nonetheless, is to be implemented using adaptive management (BiOp at 369). An initial draft adaptive management plan was prepared by the U.S. Bureau of Reclamation (Bureau) in spring 2011, reviewed by an independent panel of scientists, and subsequent amended, with that draft identified as the Milestone Draft plan.

The independent panel offered 17 recommendations regarding the plan and its implementation, underscoring the fact that the initial draft suffered from significant conceptual and technical deficiencies. The State Water Contractors Water Agency (SFCWA) agrees with the independent panel's analysis and has identified additional serious flaws in the subsequent so-called "Milestone Draft," including the fact that the adaptive management plan as described does not service the biological opinion on which it is premised. The BiOp addresses the effects of water project operations on delta smelt abundance and the extent and quality of its critical habitat. In describing the need for studies in support of the adaptive management plan, the BiOp (p. 375) lists six general study questions to be addressed:

i. What is the effect of habitat area and distribution on delta smelt distribution?
ii. How does fish condition/health vary across a gradient of habitat quality?
iii. Does fish condition/health in fall affect over-winter survival?
iv. Does fish condition/health affect fecundity and egg viability?
v. Does spatio-temporal salinity variation resulting from this fall action affect *Microcystis*?
vi. Does spatio-temporal salinity variation resulting from this fall action affect *Corbula* and the benthic invertebrate community?

Note that none of these general study questions actually assist with resolving uncertainties that attend a purported relationship between water project operations (the specific action subject to permitting under Section 7 of the federal Endangered Species Act) and the survival and recovery of delta smelt. The first general question was addressed in Feyrer et al. (2007), but inadequately so, because it did not consider the full known range of delta smelt, which can thrive even in freshwater conditions, nor explained why much of the low-salinity zone in the estuary is currently not occupied by delta smelt. To date, the second

through sixth questions have largely not been addressed in the scientific literature, and so their linkage to water project operations, if any, is only hypothetical. Likewise, it should be pointed out that the research agenda of the Milestone Draft adaptive management plan does not support the BiOp's hypothesis that water project operations are negatively affecting the abundance of delta smelt or its habitat.

Studies proposed (listed) in the Milestone Draft include:

1. Hydrodynamic and particle tracking modeling of delta smelt habitat and prey
   This study uses existing modeling tools and laboratory and field data to accomplish two broad goals. The first goal is to better understand the variability of physical habitat with variation in X2 for key fish species including delta smelt. The second goal is to better understand the population dynamics of calanoid copepods, the most important food for delta smelt in summer and fall.
2. Delta sediment measurements to support numerical modeling of turbidity
   The purpose of this 3-year study is to collect data that will support the development, calibration, and validation of numerical models of sediment transport and turbidity in the Sacramento-San Joaquin Delta.
3. Delta smelt feeding and food web interactions
   The purpose of this study is to investigate the food supply for delta smelt, how it is affected by predators and competitors, and how these interactions depend on delta outflow. This study seeks to answer two questions: (i) To what extent is growth or survival of delta smelt food limited; and (ii) What limits the availability of food for delta smelt?
4. POD fish diet and condition
   The purpose of this study is to examine the diet, feeding incidence, stomach fullness and body condition of delta smelt and some of the other POD fishes to determine if these assessments provide evidence of food limitation, either seasonal or spatial.
5. Monitoring inter-annual variability in delta smelt population contingents and growth
   The primary goal of this research is to gain a better understanding of the mechanisms (e.g., climate variability, hydrology) responsible for apparent success of different life history contingents and how entrainment as indexed by salvage at CVP and SWP could alter life history diversity.
6. Health of threatened fish: role of contaminants, disease and nutrition
   This project proposes to determine the biological effects of contaminants, pathogens/diseases, and nutritional status of striped bass, threadfin shad, splittail and tule perch from three regions in the upper estuary, Cache Slough complex, Suisun Marsh, and the lower San Joaquin River.

7. Metabolic responses to variable salinity environments in field-acclimatized *Corbula amurensis*

   This study seeks to characterize the metabolic physiology of the invasive Amur River clam *Corbula amurensis* in locations representing the extremes of their salinity distribution ranges in the northern San Francisco estuary.
8. Distribution, concentration and fate of ammonium in the Sacramento River and the low salinity zone

   The goal of this study is to determine the distribution, concentration, and fate of ammonium ($NH_4^+$) in the Sacramento River and low salinity zone (LSZ) of the San Francisco Estuary/Delta.
9. Influence of elevated ammonium ($NH_4^+$) on phytoplankton physiology in the Sacramento-San Joaquin Delta during fall

   The goal of this study is to examine how nutrients affect the food web supporting delta smelt in the low salinity zone and how nutrients in turn are affected by flow variability.

The above constitutes a collection of not uninteresting studies that have one thing in common – they have little or no direct bearing on management prescriptions in the BiOp and have little potential to determine efficacy of the Fall X2 Action or actual pertinence to the fate of delta smelt. While the referenced studies may be worthy of support, only studies 1 and 3 directly bear on the BiOp's hypothesis regarding the contribution of Delta outflow in the autumn to delta smelt population dynamics. A number of the studies are otherwise legacies of the recent pelagic organism decline research agenda (studies 2, 4, 5, 6, 8, 9). The research efforts called out in the Milestone Draft are not designed to address the putative relationship between outflow and delta smelt, nor contribute to adapting the management action based on reliable information. Rather, it is designed to prove the asserted relationship between the location of the low salinity zone and the volumes of water in that zone, which is incorrectly used in the BiOp as an indicator of the extent of habitat available to delta smelt. It is little more than a research agenda to justify the Fall X2 Action post-hoc and an acknowledgement that the BiOp lacked a legally required effects analysis. At its core, the Milestone Draft is a recapitulation of assertions regarding ecological conditions in the estuary (from the hypothesized to the well-established) and a list of broadly targeted monitoring programs and research studies. Moreover, none of the monitoring schema called out in the list of ongoing data collection efforts gathers data in a hypothesis-testing framework or tests a hypothesis that might shed light on the relationship between water-export management options in the autumn (which are to be adaptively managed) and the status and population dynamics of delta smelt. Thus, the plan lacks a most fundamental element of adaptive management (see Boesch et al. 2004). The monitoring and studies recounted in the Milestone Draft are simply not designed to inform implementation of the Fall X2 Action through adaptive management. In contrast, the Federal Columbia River

Power System Adaptive Management Plan provides specific metrics for monitoring and reporting (FCRPS 2009).

The ostensible relationship between the location of estuarine X2 in the autumn and the amount and quality of delta smelt habitat only finds support when an inappropriate definition of "habitat" is combined with an invalidly derived "habitat index" in the absence of consideration of resources essential to the survival of delta smelt. This tacitly wrong characterization of the targeted species' habitat misdirects management and has the concomitant effect of steering the accompanying monitoring scheme off track. Adaptive management simply cannot succeed if the targeted resource condition has not been linked to the demographic performance of the species that is the subject of the action. That linkage does not exist and thus cannot be drawn upon in the Milestone Draft. The data collection scheme in the Milestone Draft is an effort to establish whether the asserted relationship between X2 and habitat extent and quality actually exists. According to the Department of the Interior (Williams et al. 2009), that relationship must be supported *a priori* by empirical data, or it should not be the environmental condition used as the measureable target of the management action.

The Milestone Draft presents five pages of post-hoc hypotheses (pp. 70-74) in response to direction from the independent review panel, but it fails to explain how those hypotheses will be or can be tested by the list of ongoing and proposed studies that precede them, which were not designed to test those specific hypotheses. Under adaptive management, what data gathered where and when, and at which intensity using what tools, is to be determined by the framing and articulation of the guiding hypotheses to be tested (National Research Council 2004). By any assessment, the hypotheses listed on pages 70-74 are largely directed to issues beyond the Fall X2 Action and are otherwise ill considered. For example, one hypothesis is: "The amount of abiotic habitat for delta smelt varies with X2." Setting aside the fact that there is no such thing as "abiotic habitat," that hypothesis is the very assertion that serves as the basis for the Fall X2 Action. If that relationship has not been established as valid, the Fall X2 Action itself cannot be viewed as based on best available science and the federal agencies cannot claim that it will avoid the likelihood that water project operations will jeopardize delta smelt.

Studies not included but important to gaining an accurate understanding of the Fall X2 Action's effects include, but are not limited to:

- Measurements of *Corbula amurensis* and *Corbicula fluminea* distribution and biomass with changing X2.
- Seasonal measurements of delta smelt abundance and distribution patterns in the shorelines of Suisun Bay.

- Mesocosm experiments for defining the controlled effects of temperature and turbidity on delta smelt feeding and vulnerability to predation (suggested by the review panel).
- Experiments documenting the effect of competition and predation by inland silversides on delta smelt reproduction.
- Mesocosm experiments for defining the effect of inhibitory ammoniua/um levels and unhealthy Nitrogen:Phosphorus ratios during all seasons on production of phytoplankton.

Moreover, if one intends to better resolve the relationship between the location of X2 in the autumn and delta smelt population responses, historical time-series data are already in hand. Federal scientists have not established that it is necessary to generate new data to treat that specific issue. On the list of pertinent monitoring efforts that putatively relate to adaptive management (Milestone Draft, pp. 57-64) is the Fall Midwater Trawl survey, which has generated more than 40 years of population index data during monthly sampling (Milestone Draft, p. 64), while over the same time period diverse and extensive Delta flow data have been gathered (Milestone Draft, p. 58). If it is the position of federal agencies that those time-series data cannot be mustered to provide an investigation of the relationship between delta smelt population dynamics and autumn Delta outflows, then the appropriate step at this juncture is to identify the shortcomings in the data collection schema and propose to remedy those rather than implementing a precedent-setting management action in response to such shortcomings. In a similar vein, the Milestone Draft acknowledges the need to figure out how to reliably count the target of the Action – "to address uncertainty in estimating delta smelt abundance estimates" (p. 75). But that task is not a component of adaptive management; rather, it is a shortcoming of the available information that compromises the justification for the Fall X2 Action in the BiOp.

Adaptive management is not about using scientific and other pertinent information to identify management actions that might be effective at relieving conditions that are thought to be jeopardizing a listed species (Doremus et al. 2011). It is about better informing the implementation of otherwise well-considered management actions and restoration efforts to enhance their effectiveness, efficiency, and accountability. Adaptive management can be designed such that outcome monitoring contributes to differentiating among alternative candidate explanations for the population declines in delta smelt, but only as adjunct to refining tactical implementation of a strategically valid management action.

In the context of adaptive management, and certainly in the context of adaptive management of the Fall X2 Action, the Milestone Draft is inaccurate and incomplete. None of the essential elements of adaptive management are adequately addressed, no listing of the process steps required to link the Action and assessment activities is included and, as a

third plan draft, there is no indication that the federal agencies understand that requisite components of the process are missing.

The Milestone Draft does not exhibit four essential characteristics of a true adaptive management plan according to Williams et al. (2009). According to that source, adaptive management: (1) openly acknowledges uncertainty about how ecological systems function and how they respond to management actions, (2) is designed to improve understanding of how a system works, so as to achieve management objectives, (3) is about taking action pursuant to desired outcomes, and (4) requires the participation of stakeholders. Thus, based on the federal agencies' own definition, the Milestone Draft cannot be considered an adaptive management plan. And, as the Milestone Draft (p. 18) admits: "We cannot expect to detect an abundance difference in the FMWT after a single year of flow augmentation unless the abundance difference is very large. Other biologically important differences might not be detectable without many observations." Without knowing when a biologically important difference might be detectable, the Fall X2 Action and the Milestone Draft are best described as an exercise in trial-and-error learning rather than an adaptive management plan – an exercise that is likely to fail to improve understanding of how the Delta system works such that it can be used to inform management planning.

Williams et al. (2009) further caution against employing adaptive management when the frequency of monitoring cannot keep pace with changes in the natural system. In the case of the Fall X2 Action, many decades may be required to collect a sufficient data set for any proper statistical analysis. Over the period necessary to accrue even the limited number of data points necessary to inform implementation of the Fall X2 Action, the Bay-Delta system will adjust in many environmental dimensions independent of salinity gradients. Williams et al. (2009) warn of situations where the geographic scale of the management challenge is extensive, replication is difficult or impossible, or there are too many potentially confounding environmental factors that combine to influence outcomes (p. 15). The Fall X2 Action suffers from all of these concerns. The Milestone Draft (p. 54) admits that delta smelt and other so-called POD fishes are subjected to multiple and often interacting stressors and that recovery of delta smelt may require years or decades. Because of these multiple, interacting factors, there is no way of replicating the Fall X2 Action in an experimental context, such that identical fall flow patterns will generate the same, or even similar, outcomes.

As previously discussed, the Milestone Draft was developed largely via a process that excluded stakeholders. Other adaptive management plans, such as the Federal Columbia River Power System and the Comprehensive Everglades Restoration Plan, have successfully incorporated stakeholders from their initiation. Stakeholders have included upstream, downstream, and in-basin water users, non-governmental environmental organizations,

state and federal agencies, Native American tribes, and others. The Milestone Draft and its predecessors have not had anywhere near the same level of stakeholder involvement.

At the level of individual environmental variables that should be subject to monitoring, the Milestone Draft falls short. Tables 1 and 2 of the Milestone Draft list the abiotic, biotic, and response variables that are to be tracked. Many of the abiotic and biotic variables are broad averages over a large area (e.g., average wind speed over the LSZ) and undefined as to their derivation. For instance, will average wind speed over the LSZ be computed as a simple average of stations located in the LSZ or will it be weighted by some method? The usefulness of the abiotic and biotic variables would be enhanced by describing their derivation and use. It is impossible to evaluate the accuracy of any of the predictions in Table 1 since they are described in relation to different X2 scenarios. Since there will only be one X2 location per year and no baseline has been established, it is impossible to determine whether, for example, average phytoplankton biomass in the LSZ will be higher under the 74 km scenario – higher than what exactly?

Moreover, the Milestone Draft does not link the variables identified on Tables 1 and 2 to management actions. Without such an understanding, it is impossible to tell whether a variable is targeted for monitoring because of its potential for management, or because it is considered a covariate. For example, how will the variable "DS caught at Suisun power plants" result in management changes during the Fall X2 Action? Is there a predetermined management trigger associated with this variable? If so, what is the trigger? How will the variable be used to guide future Fall X2 Actions, if there are any?

The Fall X2 Action and its associated Milestone Draft focuses on a single management characteristic – salinity – as the determinant of delta smelt dynamics. In order to demonstrate the efficacy of that characteristic, data must be collected on all of the other candidate stressors that are believed to impact delta smelt. The monitoring data must then be connected in a multifactorial investigative framework to determine if patterns emerge which demonstrate that salinity is the most significant characteristic affecting delta smelt dynamics. While X2 position in the autumn is a favorite candidate stressor vis-à-vis the BiOp, the adaptive management plan must investigate all candidate stressors at all locations. As noted above on pages 4-5, multiple essential environmental variables, including but not limited to salinity, turbidity, temperature, prey density and type, tidal influences, bathymetric features, water depth and velocity, dissolved oxygen, presence of aquatic vegetation, and biomass of invasive clams, need to be sampled across both spatial (mid-channel to shallows, bays to marshes) and temporal gradients. The Milestone Draft's monitoring schema excludes most of these data types.

Williams et al. (2009, p. 31) appropriately notes that "learning," which is the heart of adaptive management, occurs through a comparison of model-based predictions against

estimated responses based on monitoring data. Unfortunately, the Milestone Draft's discussion on monitoring indicates that little new monitoring will take place. The review panel also noted that the study design was based mostly on existing monitoring. Except for additional macroinvertebrate monitoring, all monitoring is anticipated to be the same as at present. If the existing monitoring programs and data elements are the de facto adaptive management monitoring plan, then SFCWA does not understand the purpose of the Fall X2 Action. Apparently, the data needed to analyze the Fall X2 Action is already being collected by existing monitoring efforts; decades of time-series data on delta smelt and many environmental variables are already available. SFCWA must respectfully ask: How can more rapid learning be achieved if the same old data collection programs are used? And, conversely, if the existing monitoring is good enough, then why haven't the federal agencies fully utilized the existing datasets to gain insight before asking for additional flows?

Williams et al. (2009) calls for clear and measurable management objectives that are explicit so that progress toward their achievement can be assessed and so performance that deviates from objectives may trigger a change in management direction. Four of the management objectives in the Milestone Draft are simply to "improve understanding." There is simply no explicit metric to determine whether the improved understanding will actually occur, how it might feed back into the adaptive management process, whether it can translate into management actions, or how it can reduce uncertainties that accompany the Fall X2 Action.

A successful science plan for the Bay-Delta estuary can only be realized where a policy-management-science nexus is informed by reliable data drawn from science-based assessments, and where an understanding of Bay-Delta ecosystems is derived from data collection efforts carried out in experimental frameworks that explicitly test the effectiveness and efficacy of alternative management hypotheses. Its institutional design should foster a forum that daylights issue areas and points of scientific agreement regarding stressors on delta smelt, distinguishes issues subject to debate and disagreement, and identifies key uncertainties and issue areas in which data quality limits the inferences that can be drawn for purposes of guiding management. It should support analytical efforts that use reliable knowledge to ascertain the costs and benefits of alternative management scenarios, allowing for identification and prioritization of appropriate restoration actions, and incorporation of best practices into adaptive management.

Adaptive management can only succeed in a programmatic framework such as that offered in Figure 1 below. A close version of this decision-support structure was first presented to the then-fledgling CALFED program by an advisory panel in 1999. This approach to adaptive management was invoked incessantly by CALFED's Ecosystem Restoration Program Independent Science Board until that group's dissolution in 2005. It was

highlighted in the 2008 *State of Bay-Delta Science* synthesis volume. It is proposed yet again as the adaptive management model in the Delta Stewardship Council's draft Delta Plan. Yet the Milestone Draft offers up a governance and implementation scheme that can only be described as business as usual.

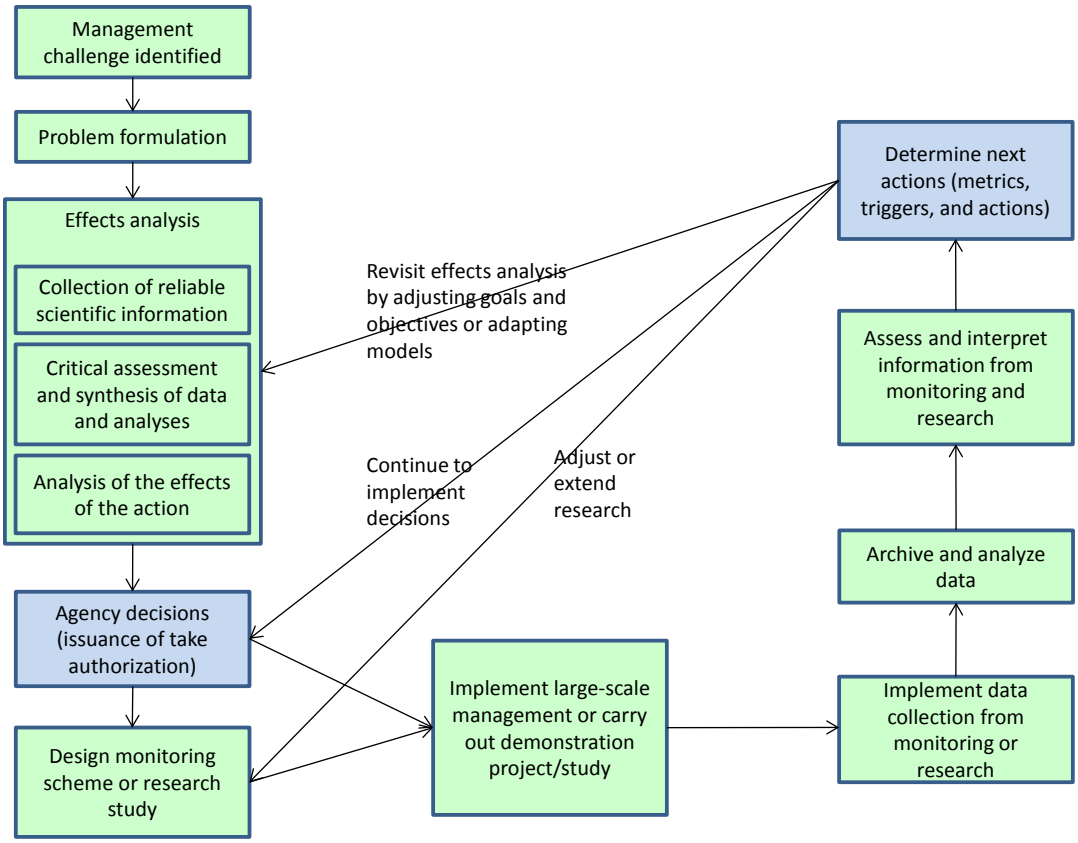


Figure 1. Adaptive management framework. Adapted from CALFED Ecosystem Restoration Program and *State of Bay-Delta Science*, 2008.

The State and Federal Contractors Water Agency encourages the independent review panel to emphatically direct the Bureau to reconsider and completely rewrite its adaptive management approach and plan. The standing version of the document functionally ignores the most fundament criticisms and recommendations that the panel delivered to the Bureau last summer. To offer planners and managers working in the estuary a montage of impertinent and uninformative existing monitoring programs and the leftover debris of an undirected, off-the-shelf research agenda in the guise of adaptive management is unacceptable and tacitly illegal. Both stakeholders and the general public – for that matter the delta smelt itself – deserve a plan that competently delivers real adaptive management to the estuary.

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